First Draft Report of the Development of Nutrient Enrichment Criteria for Iowa Streams
Stream Nutrient Criteria Technical Advisory Committee
SUMMARY OF COMMENTS

[Comments on the 7/18/2013 rough draft; Responses prepared by Tom Wilton, Iowa DNR]

Written comments received from John Olson, Iowa DNR:

1. Comment (page iv, paragraph two): Consider expanding on reason for weak relationships between nutrients and response variables.

   Response: Additional discussion of possible reasons for the observed responses was included in the August 23rd draft report.

2. Comment (page vii, recommendation one): Nutrients are not in Iowa's water quality standards, so it might be problematic to use the benchmark values to prepare water quality assessments for the 305(b)/303(d) Integrated Report.

   Response: Decisions about how to use the criteria recommendations for assessment purposes will be left to IDNR staff responsible for completing the Integrated Report. The issue was discussed with the commenter and a potential approach was identified. In order to identify nutrients as a contributing factor in aquatic life use impairment determinations, the approach requires evidence that levels of at least one nutrient parameter and one nutrient-response parameter are exceeding applicable benchmark values. In addition to this, a determination of aquatic life impairment is required based on the results from biological assemblage monitoring and/or violations of dissolved oxygen standards. The data assessment guidelines are outlined on page 172 of the August 23rd draft report.

3. Comment (page 66, paragraph two): Suggest clarifying the statement in second paragraph regarding correlations between nutrients and dissolved oxygen (DO) variables.

   Response: The statement was clarified in the August 23rd draft report.

4. Comment (page 86, paragraphs one and two): Apparently contradictory statements regarding limitation of WCHLA over BMIBI levels.

   Response: The statement was clarified in the August 23rd draft report.

5. Comment (page 87, paragraph two): Apparent contradiction of statement on page 86 regarding limitation of WCHLA over BMIBI levels.

   Response: The statement was clarified in the August 23rd draft report.

6. Comment (page 103, paragraph one): The reported result in which FIBI changepoints responded to DO minima oppositely of the expected response seems illogical.

   Response: A possible explanation for the observed response was included in the August 23rd draft report.

7. Comment (page 158, paragraph two): The term "significant resource warmwater streams" is no longer recognized in Iowa WQS.

Response: The outdated reference was removed from the August 23rd draft report.

8. Comment (page 172, item 1): Question if the statement regarding application of DO standards in nutrient assessment methodology would result in identifying cause of impairment as DO, or would it be identified as a "nutrient-related stream aquatic life use impairment"?

   Response: For clarity, it would be best to identify the impairment cause as substandard DO levels that are linked to the effects of nutrient enrichment. Ultimately, the decision about how to report the impairment cause will be left to IDNR staff responsible for completing stream water quality assessments. If the underlying cause of DO violations can be linked to failure to meet nutrient and nutrient-response parameter criteria, it would seem appropriate to identify nutrient enrichment as a contributing factor in the DO impairment. This would serve to clarify the causal pathway leading to impairment. DO violations may result from many water quality impacts including discharge of oxygen demanding substances from agricultural, industrial, or municipal sources or from instream processes such as primary production. It would be useful to somehow retain the ability to distinguish DO impairments that can be linked to nutrient-driven diel fluctuations in DO.

9. In addition to the above comments, several minor editorial suggestions were offered.

   Response: Changes were incorporated in the August 23rd draft report as needed.

Written comments received from Connie Dou, Iowa DNR:

10. Comment: The document seems to use nutrient benchmark values and nutrient criteria interchangeably. Are the nutrient benchmark values the same as nutrient criteria?

    Response: No, the two terms are not meant to have the same meaning, but I do understand why there is confusion about this. The report will be modified to reduce confusion. Nutrient benchmarks represent levels in nutrients or nutrient-response parameters determined from data analysis or from technical literature. The nutrient criteria recommendations were developed after summarizing the analysis results and benchmark values. Ultimately, the Iowa DNR water quality standards program will decide what to do with the criteria recommendations.

11. Comment: The abstract states that existing data are not sufficient at this time to support criteria recommendations for marginally perennial warmwater headwater creeks, which is later referred to as intermittent streams with perennial pools or B(WW-3) designation. It will be helpful to use the same terminology through the document.

    Response: The report will be modified to use consistent stream descriptions for criteria recommendations.

12. Comment (Table 70): Draft stream nutrient criteria recommendations include the diagnostic parameters such as dissolved oxygen diel range and filamentous algae coverage rating. Are they nutrient criteria or just being used as diagnostic parameters as described in the document?

    Response: The report will be modified to eliminate confusion about whether dissolved oxygen diel range and filamentous algae coverage rating are recommended as diagnostic parameters or nutrient criteria. As it stands in the August 23rd Draft Report, they are nutrient-response criteria recommendations.

13. In addition to the above comments, several minor editorial suggestions were offered.

    Response: Changes were incorporated in the August 23rd draft report as needed.

[Comments on the 8/23/2013 draft report; Responses prepared by Tom Wilton, Iowa DNR]

Written comments received from Mike Burkart, Iowa State University:

14. Comment: Several general statements that could be controversial have no citations [*for*] them; For example, "As demonstrated in this project and elsewhere in the Midwest Corn Belt, the occurrence of excess levels of total nitrogen and total phosphorus are often inaccurate predictors of ecosystem responses that adversely impact stream biological assemblages."

    Response: The draft report is being reviewed to identify statements needing literature citations. The TAC's assistance with this task was requested. Appropriate citations will be added to the second draft report. Because the role of nutrients in regulating instream biological and water quality responses is a very important technical issue additional discussion and citations will be added in support of the specific statement referenced on page 172 of the August 23rd draft report.

15. Comment: The report includes extensive analysis of Iowa data.

    Response: Agreed.

16. Comment: DNR staff to be commended for consistent and thorough field work and efforts to analyze data, particularly biological data.

    Response: Acknowledgement should also go to the State Hygienic Laboratory, DNR's partner organization for collection and analysis of stream biological and water quality samples since 1994. The stream nutrient data analysis would not have been possible if not for SHL's efforts and professionalism.

17. Comment: The effort to find stream reaches representing un-enriched conditions is exacerbated by the extremely modified landscapes surrounding all sampling locations.

    Response: Agreed that Iowa's landscapes have been altered extensively by human activities, and it is widely accepted that these activities have resulted in increased levels of stream nutrients above those existing prior to European settlement. It is not clear, however, which "efforts" the commenter refers to in the above statement. No such efforts or claims of documenting un-enriched conditions are discussed in the report. Stream nutrient levels sampled at reference sites were compared to levels sampled at impaired sites and random sites in Section 6 (page 140-142) of the report. However, reference sites are described in the report as representing stream locations that are "least disturbed" by current anthropogenic influences. They are not portrayed as representing pristine stream conditions of un-enriched nutrient status. Interestingly, the analysis found that reference site mean concentrations of TN and TP were lower than mean levels representing impaired sites and random sites. These results along with results showing ecoregional differences in nutrient conditions suggest that the degree of landscape modification and nutrient enrichment is not uniform across Iowa. Therefore, the characterization that all sampling locations are surrounded by "extremely modified landscapes" can be considered an oversimplification of Iowa's landscape diversity.

18. Comment: A good case has been made for defining indirect or response variables that may serve as indicators of nutrient impairment.

    Response: Agreed.

19. Comment: The use of ecoregions as delimiters for establishing interim criteria looks reasonable because the analysis of nutrient-response variables seems to provide the basis for different attainable thresholds to protect the existing ecosystems until healthier systems can be supported.

Response: The meaning of the comment is unclear. It seems to imply that ecoregions have been used as a basis for recommending nutrient criteria, which they have not. The recommendations vary by stream watershed size and thermal classification (i.e., warm vs. cold). It is also not clear what is meant by "interim criteria." The report does not use the term interim criteria in describing the criteria recommendations.

20. Comment: "The biological conditions Omernik used to defining the ecoregions did not include neither the plant nor the animal communities that dominate the regions in Iowa—corn/soybeans and swine. This makes them more physiographic regions. Perhaps it would be more accurate to define the regions using Prior's physiographic regions".

Response: The comment is not correct in asserting that U.S. EPA (Omernik) ecoregions of Iowa are primarily "physiographic regions" because they do not take into account agricultural land uses for row crop and livestock production. As described in Ecoregions of the Upper Midwest (Omernik and Gallant 1988), four primary component maps were used in delineating ecoregion boundaries: soils, land use, land-surface form, and potential natural vegetation. Agricultural census data maps were also consulted. The analysis, therefore, considered both modern land use patterns as well as natural vegetative patterns expected to occur in the absence of human activities such as agriculture, forestry, mining and urbanization. The following excerpt from Omernik and Gallant (1988) describes the Western Corn Belt Plains Ecoregion, which covers more than 75% of Iowa's surface area: "The most distinctive feature of the Western Corn Belt Plains Ecoregion is the extensive acreage in corn, soybeans, feed grains, and forage for livestock." It also states: "The irregular topography of the Western Corn Belt Plains promotes a stronger emphasis on livestock production than in the neighboring Central Corn Belt Plains. Swine are the major livestock raised, but beef cattle, poultry, and sheep are also economically important. Also, "Stream water quality is altered by crop and livestock production practices."

In contrast, Landform Regions of Iowa (Prior 1991) does not recognize differences in potential natural vegetation or land uses. Instead landforms "are distinguished on the basis of physical appearance, and their observable differences result from variations in geologic history - an intriguing combination of time, earth materials, and events." A key difference between the Prior landform map and the current U.S. EPA ecoregion map of Iowa (Chapman et al. 2002) stems from the treatment of an area in south-central Iowa. The region is recognized on the ecoregion map as the Central Irregular Plains Loess Flats and Till Plains 40(a). It also encompasses a significant adjacent area of northern Missouri. The Iowa portion is described as follows (Omernik et al. 1993. Ecoregions and Western Corn Belt Plains Subregions of Iowa): "Compared to the Western Corn Belt Plains ecoregion, which is generally all intensive cropland, this ecoregion has a mix of land use types and tends to be topographically irregular. The potential natural vegetation of the Central Irregular Plains is a grassland/forest mosaic with wider forested strips near the streams compared to the Western Corn Belt Plains where prairie grasslands predominate. The boundary between the Central Irregular Plains and the Western Corn Belt Plains in Iowa corresponds to differences in patterns on the AVHRR-NDVI imagery, on most of the soil maps, and on many of the maps of agricultural land use, crop acreage, and animal density in the Census of Agriculture (U.S. Department of Commerce 1990)."

The fact that ecoregion 40(a) encompasses differences in vegetation, soils, and land use that are not recognized on the map of Iowa landforms makes the ecoregion map a better framework for assessing stream conditions (see also Griffith et al. 1994, Ecoregions and subregions of Iowa: a framework for water quality assessment and management). Except for small regions in far southwestern and southeastern Iowa, the landform map depicts the majority of southern Iowa as belonging to the "Southern Iowa Drift Plain" landform. Despite similarities in the geologic processes shared within the region, as noted by Prior (1991), the region displays substantial variation in landscape characteristics. One important difference is the extent of silty, wind-

blown soil parent material (loess). The depth of loess deposition tends to be thinnest in south-central Iowa, farthest away from the main sources in the Missouri and Mississippi river valleys.

Soil and topographic differences are partly responsible for the observed differences in land use patterns, as well as observed differences in hydrological and water quality characteristics. For example, watersheds in Ecoregion 40(a) tend to have a greater amount of soils with low infiltration rates. Consequently surface runoff represents a relatively high proportion of annual stream flow. This contributes to less flow stability than other ecoregions. As evidenced by the analysis of random stream data in the August 23rd draft report, stream nitrate-nitrogen levels also tend to be lower than in other ecoregions. This probably reflects both the above-mentioned soil and hydrological characteristics and also the relatively lower amount of row crop land use, which requires higher nitrogen inputs.

21. Comment: Because of the extent of the analysis and the length of the report, separate and thorough reviews of the content and organization of the report should be considered for two audiences: 1- scientists who will be able to contribute to improving the analysis and attest to the credibility of recommendations arising from the report; and 2- non-technical people who will be able to support the recommendations and assist in their implementation. One or more members of the Mississippi River Collaborative (IEC is a member, Ralph Rosenberg may be able to help) should be very interested in reviewing the report in their efforts to coordinate development of stream nutrient criteria in states draining to the Mississippi.

    Response: 1- The technical/scientific review of the stream nutrient report and recommendations is being accomplished by the Technical Advisory Committee. TAC members were purposely chosen for their expertise relating to stream nutrient dynamics including nutrient impacts on stream ecosystems. 2- Although it is not required for the development of technical recommendations, approaches for presenting the technical findings and recommendations and receiving feedback from nutrient stakeholders and the general public is being considered.

    As an aside, the contents of the report reflect an objective analysis of relevant data and technical/scientific literature. The recommendations are intended to provide a science-based foundation for IDNR to make decisions relating to the development of stream nutrient criteria for the protection of designated aquatic life uses. The recommendations, however, are not meant to be prescriptive. Should a proposal for stream nutrient water quality standards be crafted by IDNR, a public review of the new rule proposal will be required by Iowa law. IDNR recognizes the value of informing the public and receiving feedback early in the rule development process, particularly as it relates to the management of nutrients.

22. Comment: The title of the report implies that all streams and uses will be discussed. For that reason, please consider expanding the discussion of general water-quality standards, particularly designated uses, specific criteria for each use, and numerical compared to narrative criteria. This kind of background should help readers understand the magnitude of the task not included in the report and particularly, the recommendations. I think the public will need an explanation of why recommendations for direct and indirect human stream contact, in particular, are not considered. It also will be helpful to include some discussion of the existing numerical criteria for any uses such as drinking water. I assume there is a drinking water criterion of 10 mg/L NO3-N. Perhaps an appropriate place for this is only in the executive summary.

    Response: Good point. Additional background information on Iowa's water quality standards will be added to the introduction section of the report. The information will address the specific issues raised in the comment. A brief synopsis will most likely also be added to the executive summary.

23. Comment: For scientific reasons and to elicit support from the public and the EPC, I encourage broadening the recommendations to include direct nutrient measures such as NO/NO2, NHx, and TN. The report, including

the executive summary, does not include adequate justification for excluding the use of these direct measures.

Response: Current results from the analysis of Iowa stream nutrient stressor-response relationships do not justify including numeric criteria recommendations for nitrite+nitrate (NOx), total ammomia (NHx), or total nitrogen (TN). Also, U.S. EPA (2000) nutrient criteria guidance does not recommend establishing nutrient criteria for dissolved inorganic nutrients such as ammonia and nitrate-nitrogen due to temporal variability in these parameters and because they do not encompass the entire pool of potentially-available nutrients. For these reasons, total nitrogen and total phosphorus are the recommended causal nutrient criteria parameters.

With respect to total Kjeldahl nitrogen (TKN), the rationale for the criteria recommendation for this parameter is provided on pages 159-160 of the August 23rd draft report. The discussion will be modified to more fully explain why criteria recommendations are not being included for other nitrogen parameters. In addition to Kjeldahl nitrogen, the importance of continued monitoring for other nitrogen forms, e.g., ammonia, nitrate-nitrite, and total nitrogen, is acknowledged in the second paragraph of page 160.

24. Comment: I realize the report is limited to Midwest conditions, and literature. However, the general literature reports evidence of the toxic effects of N03+NO2 on fish and larval stages of aquatic insects that should be considered when establishing criteria to protect aquatic life uses.

After a very quick search, I found three papers showing fish toxicity to NOx:
Eddy F B, and E M Williams, 1987, Nitrite AND Freshwater Fish, Chemistry and Ecology, 3:1:1-38.
Westin, D T, 1974, Nitrate and Nitrite Toxicity to Salmonid Fishes, 1974, The Progressive Fish-Culturist, 36:2:86-89.
Russo, R C, C E Smith, and R V Thurston, 1974, Acute Toxicity of Nitrate to Rainbow Trout (Salmo gairdneri), Jour. of the Fisheries Research Board of Canada: 31:10:1653-1655.

It is interesting that these publications are pretty old and that I found no later papers in a quick search. This suggests the findings are well accepted and have been for a long time. Perhaps Joe Larscheid could help find literature support for toxicity levels to other species found, or formerly found, in Iowa streams. There has to be some good reason why walleye are not found in streams where they were abundant in the 1970s. Two recent papers report toxicity of aquatic insect larvae to NO3 concentrations. One is exclusively a review paper than may be useful to examine:
Camargo, J A and Alonso, SA, 2006, Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: A global assessment. Environment International, 32:2006:831-849.
Also, the publication of some original research in another review on the topic may also be useful:
Camargo, J A, A Alonso, and A Salamanca, 2005, Nitrate toxicity to aquatic animals: a review with new data for freshwater invertebrates, Chemos[p]here: 58:2005:1255-1267.
I will be happy to help you access these papers if you do not have access to an extensive library or interlibrary loan.

Response: The issue of nitrate-nitrogen toxicity impacts on aquatic organisms is mentioned on paragraph two, page 160 of the draft report. The report acknowledges recent work by the Minnesota Pollution Control Agency (MPCA) (Monson 2010) in developing draft aquatic life toxicity criteria for nitrate. It recommends that IDNR consider the Minnesota study and other relevant studies at such time when a review of scientific literature is conducted for the purpose of considering potential toxicity-based water quality criteria for nitrate-nitrogen. The focus of the stream nutrient criteria recommendations project, however, will remain consistent with U.S. EPA guidance which primarily addresses the consequences of nutrient enrichment in terms of excessive biological production rather than direct toxicological effects of certain nitrogen compounds.

The Camargo et al.(2005; 2006) journal articles cited by the commenter are listed in Table 65 (page 153) of the draft report. Included in the table are nitrate benchmark values recommended by the authors. The Camargo et

al. articles cite many research studies addressing nitrite and nitrate toxicity impacts on aquatic organisms, including studies conducted by the authors cited by the commenter (Eddy and Williams 1987; Russo et al. 1974; Westin 1974). These research studies as well as new studies like Monson (2010) will be available to the IDNR at such time when a formal review of nitrate toxicity literature can be completed.

25. Comment: An extensive discussion of NH4 seems to be conspicuously absent. It seems that acute impairment caused by massive NH4 shocks provides long-term impairment to fisheries. Effects of single and repeated shocks of this nature (manure spills, municipal wastewater failures, late winter runoff, etc.) to streams deserve inclusion in a report of this nature. This is particularly important in the size of streams being recommended for implementing initial criteria. Also, the effects on aquatic life of chronic additions or in-stream production of NH4 should be included.

    Response: There is no disputing that ammonia toxicity is a serious concern. The draft report will be modified to acknowledge the significance of ammonia impairments, the role of ammonia water quality standards in protecting aquatic life, and an explanation why the stream nutrient criteria recommendations project does not specifically address ammonia toxicity as a nutrient enrichment issue.

    In accordance with federal and state laws, Iowa has adopted ammonia water quality standards criteria for the protection of aquatic life (IAC Chapter 567:61). Substantial investments in wastewater treatment and animal waste management have been made in order to prevent toxic levels of ammonia from occurring in Iowa's surface waters. While there is no disputing that accidental and noncompliant ammonia releases do result in aquatic life impairments, it is not prudent to confuse this problem with other stream impacts related to nutrient enrichment. Long-term ambient monitoring of Iowa's rivers and streams as well as random stream sampling data collected under the 2002-2006 REMAP project demonstrate that ammonia nitrogen is rarely present in concentrations above the detection limit of 0.05 mg/L. Ambient, detectable levels of ammonia that are not linked to a wastewater discharge or other pollution sources tend to occur during the winter months at levels below toxicity thresholds. Typically, nitrate levels in Iowa streams are usually one to two orders of magnitude higher than ammonia levels. Because of cellular energetics, ammonia is preferentially taken up by primary producers; however, the nitrate supply is much larger and it is also readily assimilated. Adding to temporal dynamics, ammonia is rapidly converted to nitrate in oxygenated stream environments through the process of nitrification. While episodes of ammonia toxicity and instream processes affecting ammonia availability are important to understand for other reasons, shifting the focus of this project toward these issues is not likely to produce useful nutrient criteria recommendations.

26. Comment: I suggest the relationships between Kjeldahl-N, NH4, total N, and nitrate should be discussed because nitrate is the N species most frequently mentioned in public media and NH4 may be the N species that has the most acute effect on aquatic life. The exclusion of it from nutrient criteria will reduce the credibility of recommendations with the public. Nitrate needs to be prominently included whether it is in the criteria or, if excluded, a thorough discussion of proxies for the dominant nitrogen contaminant in our streams. At minimum, an exhaustive discussion of its exclusion is warranted—refer to my comment about direct toxicity to fish and larvae.

    Response: The reference to "it" in the second sentence of the comment is unclear, but "it" presumably refers to ammonia and/or nitrate as mentioned in the first sentence. The suggestion that nutrient criteria recommendations for ammonia and/or nitrate should be included for the sake of credibility with the public is not logical or consistent with a science-based approach to criteria development.

    The point in the third sentence related to giving nitrate more prominence in the discussion of nitrogen recommendations is acknowledged. A discussion of the various forms of nitrogen and their consideration in developing nutrient criteria recommendations is provided on pages 159-160 of the August 23rd draft report. The issue of nitrate-nitrogen toxicity to aquatic organisms is addressed in paragraph two, page 160.

The discussion of nitrogen will be expanded to more fully address ammonia and nitrate and the rationale for not including nutrient criteria recommendations for these nitrogen forms.

27. Comment: The aquatic communities or indicator species, or some other descriptor(s) of the aquatic life to be protected is not explicitly stated. Some general description of the aquatic life (assemblage, community, etc.) that is to be protected would help me and certainly the public understand the importance of this stream use. Is the aquatic life to ultimately be protected a sustainable fish population of beneficial species or a group of invertebrate assemblages, both, or some theoretical assemblage? For example, a Biological Condition Rating of "Good", as shown in Table 4, (similarly a "good" FIBI as in Table 5) might be appropriate to define as the aquatic-life "use." If the BMIBI/BCR or FIBI is used to define "aquatic life" some representative or indicator species need to be defined for each stream-use class. Defining "aquatic life" more specifically will make it easier to test what direct nutrient and nutrient-response variable thresholds would impair these groups of species, assemblages or communities. There is an implication that a BMIBI of 53 may be a target. If this is the minimum condition to be protected, it would be good to state that up front and include it in the executive summary as well as a list of representative or indicator species.

    Response: The information presented on pages 21-25 of the August 23rd draft report is meant to provide background information about the biological assessment framework. The benthic macroinvertebrate and fish species assemblages are the indicator groups used to assess the health of stream biological communities protected by Iowa's water quality standards. The discussion goes on to describe the process of applying benthic macroinvertebrate and fish indices (i.e., BMIBI, CBI, FIBI) in combination with reference index benchmark levels to assess the attainment status of stream aquatic life uses. Also provided is a citation for the biological assessment protocol and criteria used to determine aquatic life use attainment for Clean Water Act reporting purposes (IDNR 2013). As indicated in paragraph two of page 22, the reference site 25th percentile index score is used as a benchmark (criterion) against which aquatic life use support status is assessed. Biological assessment criteria vary by ecoregion and also by habitat type within certain ecoregions.

    Based on the comment, it appears that what is lacking from the report is a general description of the aquatic life encompassed by the various stream aquatic life uses and how the bioassessment framework relates to the use goals. To rectify this issue, in addition to providing a brief discussion of Iowa's water quality standards and designated uses in the report introduction, additional explanation will be added to Section 3.2 "Biological indicators and benchmarks" in order to clarify the relationship between stream aquatic life designations and the biological assessment framework.

    Additional explanation of the rationale for using the statewide reference 25th and 75th percentile levels in the analysis of nutrient stressor-response relationships will be added to Section 3.2. The third paragraph of page 22 indicates that the statewide reference 25th and 75th percentile levels were used in the analysis of nutrient stressor-response relationships. The discussion notes that the 25th percentile is meant to represent an approximate threshold below which aquatic life uses will not be attained, while the 75th percentile is more representative of optimal levels of aquatic community health. The decision to apply the 25th percentile or the 75th percentile as a benchmark depended on the statistical method that was used. The biological index benchmarks used in the analysis were meant to provide a range of conditions generally representing streams that would be expected to attain stream aquatic life use goals. They were not meant to replicate the process by which the designated aquatic life use support status is determined for a specific stream.

28. Comment: It will be helpful to include in the analysis a synthesis of global literature representing basic knowledge about aquatic communities in similar climates and geology. In particular, Iowa needs help understanding the lower end of the nutrient enrichment scale which does not appear to be adequately represented in the data used for this analysis. I think this is pointed out in the report, but I could not find a discussion of the general knowledge about aquatic assemblages under low (by Iowa's enriched conditions) nutrient conditions. Steve Heiskary may be able to help you on this from Minnesota's experience and monitoring.

Response: The main point of the comment seems to relate to examining how aquatic communities adapted to nutrient-rich stream ecosystems like those in Iowa might differ from stream communities adapted to lower nutrient levels occurring in other regions of similar climate and geology. The purpose of such a comparison is not clear; however, it is assumed the commenter believes the information would be useful in developing appropriate nutrient criteria recommendations for Iowa streams. Generally, it can be agreed that a broader context for interpreting the biological assemblage characteristics of Iowa streams in relation to nutrient conditions is useful; however, the comment suggestion is somewhat problematic. The main difficulty is grappling with how to identify regions of similar climate and geology for comparison, particularly ones that also happen to exhibit lower stream nutrient levels than occurring in Iowa. Other regions in the U.S. or globally that have similar climate and geology as Iowa, if these truly exist, are also likely to be utilized for intensive agricultural purposes. Therefore, it is unlikely that such regions would be drained by streams having low nutrient levels.

The comment suggests looking into Minnesota's experience with nutrient monitoring. Section 7 (Technical Literature Review) of the August 23rd draft report discusses several Midwestern studies, including stream nutrient criteria development research conducted in Minnesota. Some of these studies examine biological assemblage responses to nutrients across a wider range of nutrient levels than is found in Iowa streams. These studies will be re-examined for findings and conclusions that pertain to the issues raised in the comment. Any relevant information gleaned from the studies will be discussed in Section 7 and Section 8 (Summary and Recommendations) of the report.

29. Comment: I suggest the abstract include a synthesis of the recommendations. I provided [*some*] suggestions in the attachment.

    Response: The suggested edits to the abstract have been reviewed and are being considered for incorporation in the second draft.

30. Comment: The executive summary is apparently written with an audience in mind that understands much of the language used by aquatic biologists. I suggest revisions so that a broader audience (EPC members?) can understand what is being recommended and the justifications for those recommendations. Consistent use of terms would help—e.g. choose one among variables/parameters/metrics unless you want to clearly define the differences for a lay/executive audience. I have attached an example of how I would reword some of the summary. I hope I did not infringe too much on the style of writing with my suggestions.

    Response: The suggested edits to the executive summary have been reviewed and are being considered for the second draft. I agree the executive summary could benefit from less technical jargon and a clear writing style suitable for a broader audience.

31. Comment: I am curious about the comment in the summary and in the main text that "… increased levels of nitrate-nitrogen, the dominant form of dissolved inorganic nitrogen in Iowa streams, were associated with decreased chlorophyll A levels." was unexpected? Why this was unexpected? La Grangian sampling of larger streams has shown declining NOx coincides with increased organic N. If stream algae are consuming NO3 in the process of producing Chl-a, why would one not expect NO3 to be less (over time and distance)? Total phosphorus includes the algae, so a positive correlation would be expected. Dissolved orthophosphate positively correlated with Chl-a is possibly the unexpected measure because it would be expected to be consumed by the algae, thus reducing its concentration.

    Response: The question about the unexpected association between dissolved inorganic nitrogen and chlorophyll A levels will be clarified in the second draft report. Nutrient uptake and assimilation in algal cells may certainly result in inverse relationships between dissolved inorganic nutrients and chlorophyll A; however, this relationship is not a given. According to Dodds (2003), concentrations of dissolved inorganic nutrients can

signal either low or high productivity depending on a dynamic balance between nutrient uptake and remineralization. For this reason and others, the author concludes that TN and TP are more reliable overall indicators of nutrient status and limitation.

Dodds, W.K. 2003. Misuse of inorganic N and soluble reactive P concentrations to indicate nutrient status of surface waters. J.N. Am. Benthol. Soc., 2003, 22(2):171-181.

32. Comment: What is the range of potential nutrient sources (e.g. wastewater discharge, agricultural fields, and other sources stated in intro) in the reference sampling sites? This is important so that readers can evaluate the use of data from these sites. It can be argued that few streams in Iowa provide examples of healthy aquatic systems because the dominant land bleeds nutrients to streams.

Response: The point is well taken. Additional discussion of nutrient sources occurring in stream reference site watersheds will be added to the report. Stream reference sites used for biological assessment are chosen to represent "best available" stream conditions specific to the ecoregion in which they are located. Generally speaking, the range of nutrient sources varies depending on land use patterns prevalent in each ecoregion. The reference site selection process strives to minimize the risk of water quality impacts from point and nonpoint pollution sources in the watershed. As watershed area increases, the occurrence of facilities such as wastewater treatment plants or animal feeding operations is difficult to avoid completely; however, consideration of characteristics such as size, proximity, and management practices are taken into consideration in the screening of candidate reference sites.

33. Comment: Relationships between nutrient variables and categorical variables of stream size, ecological region (ecoregion), and thermal regime were as expected. How does this justify not identifying criteria for the larger streams? It seems to provide the opportunity to support establishing criteria for all streams.

Response: The comment seems to imply that the report states that relationship patterns between nutrient variables and stream classification variables were "as expected, "and that this conclusion was either used or disregarded to justify not recommending nutrient criteria for larger streams. In fact, a statement referring to expected nutrient relationships in this context cannot be found in the August 23rd draft report.

The rationale for deferring nutrient recommendations for Class B(WW1) large wadeable streams and nonwadeable rivers can be found on page 166 of Section 8, "Summary and Recommendations," which states: "Nutrient criteria recommendations for large wadeable / nonwadeable streams (i.e., watershed area >700mi^2) should be postponed until additional monitoring and data analysis plans have been completed. Two main obstacles make it impractical to formulate criteria recommendations at this time. The first is insufficient data. New datasets consisting of integrated sampling data for nutrients, nutrient response variables, and biological assemblages are needed. The second obstacle is a lack of quantitatively defined biological reference conditions representing least disturbed conditions for large streams. Additional monitoring to address these deficiencies is being conducted as part of the Iowa DNR's ambient monitoring program. The new data, combined with existing data, will provide a stronger foundation for nutrient stressor-biological response data analysis."

34. Comment: As pointed out in the report, the July 1-Oct. 15 recommended sampling period avoids the season when high NOx (spring) and NHx (winter) concentrations and loads are potentially lethal to many organisms. Is it worth worrying about any long-term consequences to communities when they are wiped out annually or every few years by acute toxic nutrient events?

Response: As stated on page 1 of the report introduction: "Nutrients are chemical elements and compounds that allow organisms to grow and carry out essential life functions." The stream nutrient criteria recommendations specifically address the effects of nutrient enrichment as it relates to increased biological production and not the toxicity of certain nitrogen compounds. The release of toxic levels of ammonia is a significant concern. Ambient water quality monitoring, facility compliance monitoring, field investigations, and

water quality standards already exist as tools to protect aquatic communities from lethal ammonia releases. EPA currently does not have aquatic life toxicity criteria recommendations for nitrate and/or nitrite nitrogen.

35. Comment: Finally, perhaps a useful reference to cite. Some years ago, I was curious about the commonly used, but not often cited, stream-ordering system. I dug out the original in: Strahler, A N, 1969. Physical Geography. Third Edition. pp. 483-485. John Wiley and Sons, New York, New York. 733 pp. The first edition had the chapter as well because I remember it from a course in 1964, but I couldn't find a copy in the library.

    Response: The original citation for the Strahler stream order system will be added to the second draft report.

Verbal comments received from Kurt Pontasch, University of Northern Iowa:

36. Comment: Generally a good job was done on the analysis and report.

    Response: Thank you.

37. Comment: The emphasis on phosphorus, rather than nitrogen, is consistent with results seen in his work.

    Response: The meaning of the comment is not totally clear. The report does contain recommendations for both phosphorus (total) and nitrogen (total Kjeldahl), so in that sense one is not emphasized over the other. Probably, the commenter refers to the reported findings of a lack of significant relationships between total nitrogen and nutrient response parameters like chlorophyll A, and also the stoichiometric analysis results, which suggest that phosphorus is more likely to limit algal biomass in Iowa streams than is nitrogen.

38. Comment: Questioned which method was used for Chlorophyll analysis; remarked that field probes do not produce reliable readings.

    Response: All nutrient and chlorophyll A data presented in the report were analyzed in the laboratory using EPA-approved methods.

39. Comment: Suggested adding listing of nutrient analytical methods to report.

    Response: Agree this will be beneficial. A table of water quality parameter analysis methods will be added to Section 2.2, "Sample collection and analysis procedures" in the second draft report.

Written comments received from Chris Jones, Iowa Soybean Association:

40. Comment: Congratulations on producing a thorough examination of Iowa data.

    Response: Thank you.

41. Comment: Biggest struggle is with nitrogen. Difficulty in predicting optimal N application rate to agricultural fields based on yield goal is similar to difficulty in predicting N response in streams. Other factors besides application rate ultimately will determine yield; tight statistical relationships are illusive even at field scale.

Response: Generally agree with the analogy.

42. Comment: Not comfortable with TKN as a criterion. Is more a "consequence of (like the algae bloom itself) of N enrichment via other forms, in contrast to P, which is clearly a predictor."

Response: Agree that TKN is mostly an expression of biological production. Page iv of the Executive Summary and the 2nd paragraph from the bottom of page 16 attempt to convey the idea that TKN is more useful as a general indicator of nutrient enrichment or trophic status rather than as an indicator of nutrient availability or as a "causal" nutrient parameter in terminology used in EPA guidance. TP is also problematic as a nutrient "causal" indicator because it encompasses all forms of P, some readily-available and other forms not as available, including the P contained in algal cells or tightly bound to sediment particles.

Based on this comment and the discussion at the November 25th TAC meeting, consideration is being given to removing TKN from the list of criteria recommendations. Omitting TKN might be a good idea if the recommendation only results in confusion about what TKN represents and how to implement the recommendation. One concern about dropping TKN is potentially losing it as a surrogate indicator for increased risk of low DO levels, of which it is a reasonably good predictor. Continuous diel DO monitoring data are more expensive to obtain and not as commonly available as TKN data. Even if TKN is dropped from the criteria recommendations, however, the TKN benchmark values for warmwater and coldwater streams might still be useful as diagnostic indicators for nutrient impact assessment purposes.

43. Comment: Agree that nitrate doesn't correlate well with chlorophyll A. High levels seen when flows are high and algae growth is low. Highest levels of algae growth are in late summer when nitrate levels are lowest.

Response: Agree with this characterization of the relationship of nitrate and chlorophyll A.

44. Comment: Encourage examination of nitrogen toxicity (i.e., ammonia, nitrate) to fish and invertebrates. Wonder if N toxicity is correlated with P, and whether P levels somehow influence toxicity of N?

Response: See response for comment #11 regarding the issue of addressing ammonia and nitrate toxicity as part of nutrient criteria development. With regard to potential correlations or interactions of phosphorus with ammonia or nitrate toxicity, I am not aware of any such documented relationships; however, I would be happy to review any studies that TAC members might be able to forward to me.

45. Disagree with statement on page VI of the Executive Summary regarding targeting monitoring for instream nutrient impacts to low flow summer period. Suggested that P loading and sediment storage of P during high flows occurring at other times of year has stream consequences during low flow because of sediment P release.

Response: Agree that phosphorus loading during periods of high flow may contribute to problems during the low flow period when nutrient-related aquatic life impairments most often occur. Sediment release of phosphorus and its relative contribution to nutrient-related impairments is not easily quantified. More research of this phenomenon is needed. The intended meaning of the referenced statement is that it is preferable to monitor nutrient-biological response relationships during the summer-early fall period for consistency with the time of year the nutrient-biological response relationships were documented and nutrient criteria recommendations developed. The statement was not meant to diminish the importance of monitoring

during other times of the year to establish source loads or examine instream contributions. Once a nutrient-related aquatic life impairment has been identified, more intensive monitoring of nutrient levels and flow throughout the year are critically important for understanding the timing of nutrient delivery and quantifying the contributions of point and nonpoint sources in the watershed. These data are required for developing load reduction targets designed to eliminate the impairment.

Written comments received from Clay Pierce, Iowa State University

46. Comment: Incorporation of habitat and possibly other environmental data in a multivariate analysis might help reveal nutrient impacts if confounding effects could be statistically controlled for. Keith's comment about conducting experimental studies with sites selected and treatments designed a priori would be another excellent way to address these questions.

    Response: Agree with the suggestion that multivariate analysis might help clarify the role of environmental factors (other than nutrients) in the expression of stream nutrient impacts. The correlations and potential interactions of benthic macroinvertebrate IBI metrics, dissolved oxygen minima, habitat characteristics, and periphyton chlorophyll A that were discussed on page 108 of the August 23rd report suggest that such relationships are important. I also agree that carefully designed field experimental studies are more likely to succeed in providing useful data.

47. Comment (page ii, paragraph three): I'd like to see (or do!) an analysis of nutrient effects that included the effects of physical habitat and perhaps other environmental factors on biological communities. I think you'd get a better sense of the effects of nutrients if other important factors were accounted for in the analysis.

    Response (also see response #46): As discussed at the November 25th TAC meeting, the data analysis focus until now has been on examining relationships of nutrients, nutrient response variables, and biological assemblage indicators. Significant changepoints or thresholds in these relationships have also been identified to inform the development of nutrient criteria recommendations. The substantial observed variability in nutrient response relationships, in addition to results from other research studies like those sponsored by the Illinois Council on Food and Agricultural Research (CFAR), strongly suggest that other environmental factors such as hydrology and physical habitat affect the expression of stream nutrient impacts. Now that the first phase of nutrient data analysis has been completed, there is good justification to consider a follow-up multivariate data analysis as suggested in the comment. The recommendations of the August 23rd draft report did not address multivariate data analysis needs. A new recommendation that will address data analysis and field research needs is being considered for the second draft of the report.

48. Comment (page v; Nutrient enrichment criteria recommendations for wadeable warmwater streams): Is it the diel range, or the diel minimum? The text suggests it is the minimum.

    Response: The recommendation is for diel dissolved oxygen range. The text reference will be modified to avoid confusion.

49. Comment (page v, paragraph three, second sentence): Delete "provide" from sentence.

    Response: The deletion will be made in the second draft report.

50. Comment: (page 18, paragraph five, last sentence): Change 1999 to 2009 for both Rowe et al. citations.

    Response: This change will be made in the second draft report.